



A Changing Climate in Hawaii's National Parks

2014 Calendar



U.S. Department of Interior
National Park Service

Pacific Island Network
Inventory & Monitoring Program



During each month of this calendar you will learn more about climate change in Hawaii, common misconceptions, and meaningful measures you can take to help the Earth.

Pacific Islands Climate Change Affects YOU

So what's it all about ?

The Earth is getting warmer and higher temperatures mean big changes for the entire planet, including those of us who live on Pacific islands. The surface of the Earth has warmed about 1°F since the mid-1970s and the eight warmest years on record have all occurred since 2001. By the end of this century, the best estimate of temperature increase is 5.4°F. Oceans are also becoming warmer and more acidic due to the absorption of carbon dioxide (CO₂) into the water, creating carbonic acid. These effects, and others related to human induced changes like sea level rise, are known as climate change.

Greenhouse gasses, such as CO₂ and methane, allow heat from the sun to be absorbed by the land and the ocean. This natural effect keeps the earth at a stable temperature, however the vast amounts of greenhouse gasses that humans have released through our burning of fossil fuels (coal, oil, etc.) has vastly increased CO₂ concentrations since the Industrial Revolution.

The last time CO₂ levels were this high was at least 15 million years ago before humans even existed. Back then, global temperatures were 5-10°F higher with sea levels 75 to 120 feet higher, and very little permanent ice on Earth. This is extreme, but it may be the direction that the Earth is heading.

If we can't curb our thirst for CO₂ producing fossil fuels, then conditions on Earth will be dramatically different for humans in the future. Even today, we can already see changes happening to the land, sea, and everything (and everyone) that lives on the planet.

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National park areas in Hawaii (dark brown)



Changing Climate In Hawaii Affects **NATIVE PLANTS**

Hawaii is home to a truly unique group of native plants that evolved from a few ancestral species to over 1,000 plant species. Due to habitat destruction and the competition from non-native species, many of these plants are threatened or endangered. Climate change presents a new threat. As rainfall and vegetation patterns change across the islands, aggressive invasive plants often have a competitive advantage over native plants. For example, when a landscape becomes drier it becomes more susceptible to fires. Once a fire has ravaged an area, fire tolerant invasive grasses like fountain grass move in and dominate an area that might otherwise be covered by native species.

Another way in which native plants suffer from climate change involves elevation and mauka (mountain) forests. Most invasive plant species are well adapted to warmer, lower elevations. Through the years, many native plants have conversely maintained cooler mountain strongholds. Mauka temperatures in Hawaii are increasing at a rate of about 0.5°F every decade. The aggressive plant invaders will find it easier to move upslope into native habitats as a result.

February **MYTH Buster**

"I am just one person. I can't make a difference."

This couldn't be further from the truth. The best way to reduce our consumption of fossil fuels is one person, one family, and one community at a time. Every small effort from each individual adds up to make a real difference for the future of our world.

This Month I Will Make a Difference

by carpooling more often.

February

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'Ama'u fern



Changing Climate In Hawaii Affects **SEVERE STORMS** and **DROUGHT**

When it rains, it pours, at least that's often true in Hawaii. But when it doesn't rain much or at all for a long time, it's called a drought. A warming climate increases the frequency and intensity of both tropical storms and droughts. These two statements appear contradictory, but this trend is predicted to continue. Hawaii has experienced a statewide decline in rainfall over the past two decades. However, the amount of rain from heavy storms has increased by 12%.

Climate models project that Hawaii will experience up to a 10% reduction in wet season precipitation and a 5% increase in dry season precipitation by 2100. Climate models also project that the frequency and intensity of cyclones in the greater Pacific will increase by the end of the 21st century. One model even predicts twice as many hurricanes.

The effects of more severe storms and droughts can be catastrophic for natural and cultural resources, for infrastructure like roads and bridges, and for people's health, homes, and livelihoods.

March MYTH Buster

"Scientists don't agree about climate change."

According to a recent survey by the Intergovernmental Panel on Climate Change (IPCC), 97% of climate scientists agree that global climate change is occurring and that human activity is the primary cause.

This Month I Will Make a Difference

by riding my bike or walking whenever I can.

March

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16	17	18	19	20	21	22
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23	24	25	26	27	28	29
			Prince Kūhiō Day			
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A storm moves over the Hawaiian Islands



Changing Climate In Hawaii Affects **COASTAL HABITAT**

Due to rising temperatures, the planet's ice has dramatically melted. When amplified by the thermal expansion of water, it results in global sea level rise. Not all islands will experience the same rate of sea level change. For example, the Kona Coast is experiencing a sea level rise of about 1.5 inches per decade. This trend is gaining speed. The regional sea level is predicted to rise 7-23 inches by 2100.

Rising ocean water encroaches on freshwater aquifers. Saltwater intrusion affects coastal habitats such as anchialine pools. Many plants and animals depend on a delicate balance in these pools. As the sea level rises some of the pools will become too salty, and others will disappear completely.

At the same time, a decline in the health of coral reefs due to climate change could expose shorelines to more waves and storms. This significantly increases vulnerability for nearshore estuaries, beaches, coastal vegetation, and anchialine pools. Beach erosion is already a serious and expensive issue in Hawaii.

April MYTH Buster

"How can we have harsh winters and global warming at the same time?"

While we may use the terms "climate" and "weather" interchangeably, they are two very different things. "Weather" describes day-to-day conditions; "Climate" is the average of these weather conditions over long periods of time.

This Month I Will Make a Difference

by reducing, reusing, and recycling. Producing new materials requires tremendous energy.

April

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*Ōpae 'ula (red shrimp)



Changing Climate In Hawaii Affects **NATIVE BIRDS**

Air temperatures are increasing at a much higher rate on Hawaii's mountains than along the coasts. Currently, high elevation forests are the primary refuge for our few remaining native bird species because avian disease-carrying mosquitoes cannot survive the cooler temperatures. However, increasingly warmer conditions will allow mosquitoes to survive at higher elevations. Native birds cannot simply move further upslope because the habitat is often unsuitable. Just on Hawai'i Island alone, the incidence of malaria in forest birds has more than doubled over a decade, in correlation with warmer summer air temperatures and an increase in mosquito breeding.

Ninety-three percent of Hawaiian birds are considered vulnerable to climate change. The very existence of birds such as 'i'iwi which live mainly in high-elevation forests, is threatened by rising temperatures. For example, a 3.6°F rise in average regional temperature could cause an important natural reserve on Maui to lose 57% of its remaining low-risk area for avian malaria, increasing the risk of infection to birds like the endangered kiwikiu and 'ākohekohe.

May **MYTH** Buster

"People don't cause climate change."

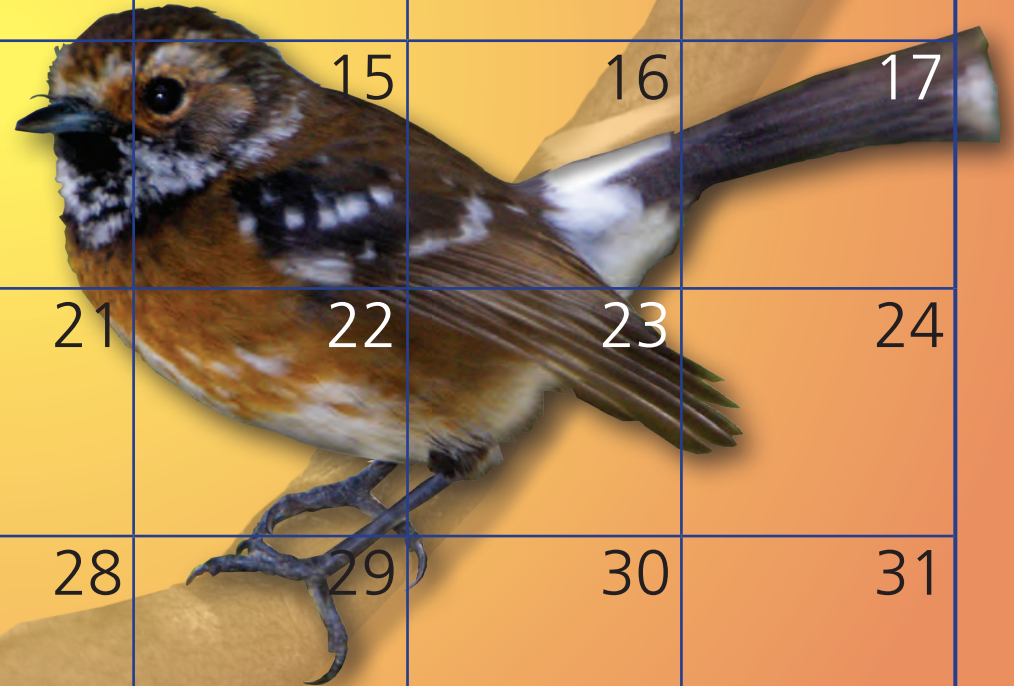
People affect their environments. The climate change trends we are seeing today are directly related to increasing levels of greenhouse gases that people released from burning coal, gas, and oil starting in the 19th century.

This Month I Will Make a Difference

by changing all of my light bulbs to energy savers.

May

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*Elepaio (photo by Jack Jeffrey)



Changing Climate In Hawaii Affects **CORAL REEFS**

Oceans absorb over 80% of the heat added to the climate system, and about 30% of the CO₂ released by humans. When CO₂ dissolves in seawater, carbonic acid is created making more acidic oceans. A warmer and more acidic ocean will not be hospitable for coral reefs. Coral organisms are very sensitive to heat stress and expel their colorful symbiotic algae (bleaching) when the water warms. Corals also form their hard skeletons from calcium, an ability compromised as the oceans continue to become more acidic.

Few coral bleaching events were recorded before 1980. Since then many events, including a mass bleaching event in the 1990's that killed 16% of the planet's coral, are on record. As oceans continue to warm, bleaching will become more frequent and severe.

By mid-century, temperature and CO₂ levels are predicted to increase beyond levels experienced for at least a half-million years. The dual threats of ocean acidification and warming lead some scientists to believe that most of the world's coral reefs will disappear by the end of the century.

June MYTH Buster

"Climate science seems like guesswork."

The specific effects of climate change are uncertain (e.g., how much the temperature will increase). Despite this, it would be far riskier to do nothing. We must move forward with the best tested and most rigorous science we have today.

This Month I Will Make a Difference

by eating locally grown food (reduces food transport).

June

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Corals



Changing Climate In Hawaii Affects Cultural Sites

Many historical Hawaiian sites are located along the coasts. Temples, burial and ceremonial sites, as well as the remains of villages are found near the ocean. The National Park Service is just one of many organizations entrusted with protecting these irreplaceable treasures. Climate change poses an enormous obstacle to this endeavor.

The combination of sea level rise, erosion, and storm surges near the ocean are grave threats to culturally significant coastal sites. And coastal cyclonic activity has been known to destroy entire archeological assemblages.

Pelekane Beach at Pu'ukoholā Heiau NHS, the trail system of Ala Kahakai NHT, and the royal fishponds at Pu'uhonua o Hōnaunau NHP are just a few examples of sites identified as threatened by sea level rise. At Kaloko-Honokōhau NHP, the Kaloko Seawall, the beach fronting 'Aimakapā Fishpond, and 'Ai'ōpio Fishtrap are at even greater risk due to climate change related coastal impacts.

July MYTH Buster


"Alternative energy just isn't practical."

This is short sighted. While alternative energy production may be more expensive in the short-term, when long-term costs such as pollution, global warming, and quality of life are factored in, alternative energy is by far more cost effective.

This Month I Will Make a Difference

by conserving water. Even where water is plentiful, it takes energy to pump it.

July

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Cultural resources along the coast



Changing Climate In Hawaii Affects **STREAMS**

Powerful and serene, waterfalls are an iconic feature in Hawaii. Continuously flowing freshwater is, however, rare on islands. In Hawaii, rainfall combines with geographic features (e.g., waterfalls) to produce unique ecosystems. Many streams in Hawaii harbor native creatures like 'o'opu that climb steep waterfalls to reach upstream habitats. These special habitats are often a refuge for native stream animals because lower areas are dominated by non-native species.

There is less overall rainfall in Hawaii. Since the 1940's, the amount of freshwater in Hawaiian streams has measurably declined. These patterns, coupled with warmer air temperatures across the state could increase evapotranspiration, resulting in even less stream flow. If stream flow is reduced to the point of absence or stagnation in upper reaches, there will be severe impacts to this native animal refuge.

Native stream species are not the only concern. Compromised groundwater and stream discharge poses a threat to the plants, animals, and even the reefs in coastal areas. People depend on freshwater too.

August MYTH Buster

"Climate change isn't affecting us."

We are seeing impacts in many places around the world. The most dramatic are visible in northernmost latitudes, along the coasts, and in high-elevation habitats. Many fragile ecosystems and resources in these places are in danger of disappearing forever.

This Month I Will Make a Difference

by turning my car engine off while idling.

August

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Statehood Day

Damselflies live near freshwater



Changing Climate In Hawaii Affects The Economy

The Hawaii economy relies significantly on tourism, fisheries, and agriculture. All three are under threat as the climate changes.

If coral reef ecosystems are damaged by warming oceans and acidic seawater, then the fisheries dependent on the reefs will also suffer. Tourists flock to Hawaii for the beautiful coral reefs and the white sand beaches created by natural coral erosion. The net economic benefits of coral reefs for Hawaii are estimated at \$360 million annually, with the overall tourism value estimated at over \$10 billion.

Any roads, parks, and buildings near the coast are vulnerable as the sea level rises. Rebuilding will be expensive and sometimes impractical. Significant areas of economically important Honolulu will be susceptible to floods with higher sea levels. The Hawaii economy is intimately tied to a healthy environment.

Agriculture in Hawaii is a vital industry for a state that otherwise imports most of its food. Temperature, precipitation, and the intrusion of saltwater into freshwater systems all have the potential to harm agricultural production. Taro farming, for instance, is often acutely vulnerable to sea level rise.

September MYTH Buster

"The sun is causing climate change."

The sun's activity does affect Earth's seasonal cycles, but on timescales of thousands of years.

This Month I Will Make a Difference

by telecommuting or web conferencing.

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A diver spots a honu (turtle)



Changing Climate In Hawaii Affects **MOUNTAINS**

Higher elevations on some Hawaiian Islands keep many native species healthy thanks to cooler temperatures that are less hospitable to the many non-native species that have invaded Hawaii. Many of these last mountain refuges are threatened by climate change. As the environment warms, an upslope migration of non-native and invasive plants, insects, and other animals is occurring.

In Hawai'i Volcanoes NP, for example, Argentine ants and coqui frogs will be able to gradually move upslope as the climate warms. Collectively, they eat a tremendous amount of insects which some native plants depend on for pollination. Invasive plant species may also out-compete native species at higher elevations as the climate changes to conditions where native species are not well adapted.

Average temperatures on Pacific islands have risen by 0.5°F over the past century. In Hawaii, temperatures at higher elevations are now increasing by nearly this rate every decade. If this trend continues, Hawaii's last, best refuge for native species will be lost.

October **MYTH** Buster

"Isn't climate change a natural process?"

Earth's temperature fluctuates naturally over tens of thousands to millions of years. Scientists take these fluctuations into account when they assert that we are currently experiencing unique conditions in Earth's history. And humans are the cause.

This Month I Will Make a Difference
by composting my food waste.

October

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‘Āhinahina or silversword



Changing Climate In Hawaii Affects FISH and INVERTEBRATES

Over 20% of the marine fish and invertebrates found in the waters of Hawaii are unique to our islands. Marine invertebrates include: sponges, anemones, mollusks, sea cucumbers, and many other creatures.

As CO₂ is absorbed into the ocean creating carbonic acid, the oceans gradually become more acidic. While the damage to coral species is easy to envision due to their identifiable calcium skeletons, the damage to other marine creatures is more subtle. Scientists are only beginning to understand the long-term impacts to fish and invertebrates. It is known that many of these animals develop skeletons of calcium carbonate, a process very sensitive to seawater acidification, especially during the earliest stages of life and growth.

The negative effects of ocean acidification and rising seawater temperatures combine to more significantly impact marine animals than either would alone. For example, a decline in oyster reproduction was intensified when both factors were combined.

November MYTH Buster

"Volcanoes make more greenhouse gases than people."

Active volcanoes do produce a substantial amount of greenhouse gases. But if the emissions of every volcano in the world were combined, they would only account for less than one percent of greenhouse gas emissions. Far less than what people produce.

This Month I Will Make a Difference
by turning off the air conditioner.

November

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30						

Slate pencil urchin



Changing Climate In Hawaii Affects **HUMAN HEALTH**

Temperatures are predicted to rise an average of 4°F in the Pacific islands by 2090. While Hawaii climate is moderated by the Pacific Ocean and the heat waves that hit continental locations are not common, the higher temperatures we will experience disproportionately affect the health of our most vulnerable residents, while making it more uncomfortable for all of us. But it is not the heat itself that poses the greatest risk to human health. As the temperature warms and the Hawaiian Islands become drier, water shortages could increase, for example.

The increased frequency of large storms projected with climate change not only directly affects humans through damaging winds and storm surges, but they also create environmental conditions that favor mosquitoes and vermin. Standing water left by large storms can cause mosquito outbreaks that can transmit diseases. For example, in the 1990's, wet and warm conditions contributed to 13 dengue fever deaths in Fiji.

December **MYTH** Buster

"Temperatures in Hawaii are the same as ever"

If you live near the coast this may seem true. The temperature increase at the coast is slight, and actually below the global average. However, temperatures in Hawaii's mountains are increasing at a rate of about 0.5°F per decade. This rate is well above the global average.

This Month I Will Make a Difference

by challenging others to think about reducing their carbon consumption.

December

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28	29	30	31 New Year's Eve		November 2014 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	January 2015 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

National park visitors participate in a communal fishing demonstration





"...climate change has certainly made things interesting. How will we choose, as the sea rises, which cultural sites we save? How do we decide that the next site for the giant sequoias is hundreds of miles north? Are those warblers here for the first time treated as exotics? These are difficult questions. More than the future of the national parks hangs in the balance, but I am confident that the NPS will play a critical role. "

***~ J. Jarvis, Director
National Park Service***

2014 Calendar



U.S. Department of Interior
National Park Service

Pacific Island Network
Inventory & Monitoring Program

Painting by Rochelle Mason